

# Effect of sowing and harvesting times on growth characters and grain yield of *rabi* rice (*Oryza sativa* L.)

## ABSTRACT

**Keywords:** *Rice varieties, sowing and harvesting dates, growth characters, grain yield.*

## 1. INTRODUCTION

Rice (*Oryza sativa* L.) is one of the world's most important food crop, providing 70 % direct employment in rural India and forming the staple diet of billions of people. Rice cultivation is critical to Asia's food security because it accounts for more than 90 % of rice production and consumption. Rice provides 32-59 % of dietary energy and 25-44 % of dietary protein. Rice demand is expected to rise by 70 % in the next 30 years to maintain current per capita availability (69 kg yr<sup>-1</sup>), while keeping land productivity constant Patra and Haque [16].

Rice production is the world's single largest land use for food production, covering 164 M ha and producing about 750 million tonnes of paddy each year FAO [6]. India is the second largest producer of rice after China. In India, rice is cultivated in 45.7 M ha with production of 124.3 million tonnes and productivity of 2717 kg ha<sup>-1</sup> GOI [10].

The timing of transplanting in rice is critical to ensure adequate vegetative growth during a period of moderate temperature and high solar radiation. Proper transplanting date for each cultivar ensures that the cold sensitive stage occurs when the minimum night temperatures have historically been the warmest and planting at the right time ensures that grain filling occurs when temperatures are more likely to be mild, resulting in high-quality grain Farrell et al.[8]. Transplanting too soon or too late reduces yields in ways that no other input or practice can compensate for Kapoor et al.[11]. Temperatures that are too high or too low can affect flowering and prevent pollen shedding, resulting in high infertility and chaffy grain production, resulting in yield loss. To achieve a maximum yield level and quality of grain, it is necessary to optimise transplanting time. The harvesting of the crop at the right time ensures the maximum quantity and quality of rice. Harvesting the crop too early may result in a lower yield of the crop with poor quality grains as there will be a number of green or immature grains. If the rice crop is harvested too late, the grains may shatter and be eaten by birds and rodents, resulting in grain loss. Grains develop sun cracks as a result of over-maturity and over-drying in the field, resulting in severe breakage during milling. A critical evaluation of the optimal harvest stage is considered necessary for farmers to maximize the return on their produce.

Of the total rice crop area of 45.7 M ha in India, the *kharif* and *rabi* percentages are 88.18 and 11.81 respectively, where as in Telangana, the rice crop area in *kharif* and *rabi* season are almost same ( 20.99 M ha and 20.78 M ha ) which as a unique GOT [9]. Traditionally, Telangana farmers used to cultivate market demand fine grain varieties to the tune of 40 % in *kharif*, where as in *rabi*, almost 90 % of rice area with long slender grain type varieties . The long slender grain varieties are procured by government through Indira kranthi pathakam right from the villages. Telangana *rabi* rice season is typical with sunny days, cold nights (large diurnal variations) and temperatures raising sharply from March onwards with low relative humidity. These weather conditions though very good for higher yields , at the same time limits the quality of rice (Low head rice recovery). To minimize the broken rice percentages, millers practices paraboiling for *rabi* rice. This rice is exported to Kerala, Tamil Nadu and other southern states for grain consumption. But those too have started cultivation of long slender varieties to meet their needs. As a result, there is no market for long slender varieties. As the buffer stocks (268.32 mt) are sufficient, the Food Corporation of India is not showing much interest to purchase parboiled rice during the *rabi* FCI [7]. With the change of central government policy of not to procure parboiled rice is big jolt to the farming community of Telangana state.

It is well known fact that, *rabi* sowing time depends on the harvestings of the previous *kharif* farmers rice crop. The different rice agroecosystems coupled with farmers management practices (varieties, fertilisers, systems of cultivation) are the right reasons for different sowings in *kharif* ultimately different harvesting dates. Farmers in Telangana starts *rabi* nursery sowing from 10<sup>th</sup> November to 20<sup>th</sup> January, subjecting the rice crop to wide environmental variations. Though some studies were carried out regarding performance of long slender rice varieties in *rabi* season. pertaining to yield Anil and Siddi.[1], no research studies were conducted with market demand fine grain rice varieties especially under delayed sowings/ harvestings, which is a common problem in most of the farmers fields. By considering all the above facts, the following work was put forth.

## 2. MATERIAL AND METHODS

A Field experiment was conducted during *rabi* season of 2021 at Rice Research

Centre, Agricultural Research Institute, Rajendranagar, Hyderabad with eighteen treatments laid out in strip plot design with three replications. The soil of experimental site was clay loam in texture and slightly alkaline in reaction (pH 7.8), low in organic carbon (0.48 %) and available nitrogen (213 kg ha<sup>-1</sup>), high in available phosphorus (27.2 kg ha<sup>-1</sup>) and potassium (453.1 kg ha<sup>-1</sup>). Treatments included were 3 treatments of varieties (i) M<sub>1</sub>=Telangana sona (ii) M<sub>2</sub>= Jagtial rice 1 (iii) M<sub>3</sub>= Chintu and 6 sowing and harvesting dates (i) S<sub>1</sub>= Normal sowing time (November 15) and harvesting at physiological maturity (ii) S<sub>2</sub>= Normal sowing time (November 15) and harvesting at 7 days after physiological maturity (iii) S<sub>3</sub> = Delay sowing by 15 days (November 30) and harvesting at physiological maturity (iv) S<sub>4</sub>=Delay sowing by 15 days (November 30) and harvesting at 7 days after physiological maturity (v) S<sub>5</sub>=Delay sowing by 30 days (December 15) and harvesting at physiological maturity (vi) S<sub>6</sub> =Delay sowing by 30 days (December 15) and harvesting at 7 days after physiological maturity randomly placed in subplots of the main plot. Nursery of three varieties *i.e.*, Telangana sona, Jagtial rice 1 and Chintu was raised as per the dates of sowing *i.e.*, 15<sup>th</sup> November, 30<sup>th</sup> November, 15<sup>th</sup> December. The sprouted seeds were broadcasted on well prepared raised beds adopting seed rate of 50 kg ha<sup>-1</sup>, 62.5 kg ha<sup>-1</sup> and 15 kg ha<sup>-1</sup> respectively maintaining a spacing of 15 cm x 15 cm. The crop was fertilized with 150-60-40 Kg ha<sup>-1</sup> N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O in the form of urea, DAP and MOP.

**Comment [A1]:** Give a diagram of plot design

**Comment [A2]:** Please give detail information of the three varieties (Like, duration, potential yield or any other significant characteristics) and why these varieties were selected for the study?

### 3. RESULTS AND DISCUSSION

#### 3.1 Growth parameters

##### 3.1.1 Plant height

The data pertaining to plant height (cm) was depicted in Table 1

##### 3.1.1.1 Rice varietal performance

At 30 days after transplanting, significantly higher plant height was observed in M<sub>1</sub> (Telangana sona) and was on par with M<sub>2</sub> (Jagtial rice 1), which was in turn on par with M<sub>3</sub> (Chintu). At 60 days after transplanting significantly higher plant height was observed in M<sub>1</sub> (Telangana sona) over all other varieties followed by M<sub>2</sub> (Jagtial rice 1), which was on par with M<sub>3</sub> (Chintu). At 90 DAT, similar trend was observed like that of 30 DAT. At harvest, similar trend was observed like that of 60 DAT. It may be due to the genetic character of the variety. The results consistent with the findings of Nizamani et al. [14] and Suleiman et al. [18], who observed plant height, differed significantly among the varieties.

##### 3.1.1.2 Performance of rice under varied sowing and harvesting dates

At 30 DAT, S<sub>5</sub> (Delay sowing by 30 days (December 15) and harvesting at physiological maturity) shown significantly higher plant height and was on par with S<sub>6</sub> (Delay sowing by 30 days (December 15) and harvesting at 7 days after physiological maturity), which was in turn on par with S<sub>3</sub> (Delay sowing by 15 days (November 30) and harvesting at physiological maturity) and S<sub>4</sub> (Delay sowing by 15 days (November 30) and harvesting at 7 days after physiological maturity). The lowest values of plant height was observed in S<sub>2</sub> (Normal sowing time (November 15) and harvesting at 7 days after physiological maturity). At 60 DAT, significantly higher plant height was observed in S<sub>5</sub> (Delay sowing by 30 days (December 15) and harvesting at physiological maturity) and was on par with S<sub>6</sub> (Delay sowing by 30 days (December 15) and harvesting at 7 days after physiological maturity), followed by S<sub>3</sub> (Delay sowing by 15 days (November 30) and harvesting at physiological maturity), which was in turn on par with S<sub>4</sub> (Delay sowing by 15 days (November 30) and

harvesting at 7 days after physiological maturity). The lowest plant height was recorded in S<sub>2</sub> (Normal sowing time (November 15) and harvesting at 7 days after physiological maturity). At 90 DAT, S<sub>5</sub> (Delay sowing by 30 days (December 15) and harvesting at physiological maturity) shown significantly higher plant height and was on par with S<sub>6</sub> (Delay sowing by 30 days (December 15) and harvesting at 7 days after physiological maturity), followed by S<sub>3</sub> (Delay sowing by 15 days (November 30) and harvesting at physiological maturity), which was inturn on par with S<sub>4</sub> (Delay sowing by 15 days (November 30) and harvesting at 7 days after physiological maturity) and S<sub>1</sub> (Normal sowing time (November 15) and harvesting at physiological maturity). The lowest plant height was observed in S<sub>2</sub> (Normal sowing time (November 15) and harvesting at 7 days after physiological maturity). At harvest, similar trend was observed like that of 90 DAT. Plant height is directly proportional to the length of the vegetative phase of the crop. Koireng et al. [12] reported that significantly different responses of different genotypes to various management variable and environments with respect to growth attributes due to inherent characteristics.

### 3.1.2 Number of tillers m<sup>-2</sup>

The data pertaining to number of tillers m<sup>-2</sup> was depicted in Table 2

#### 3.1.2.1 Rice varietal performance

The data presented in Table 2 shows that at 30 DAT, M<sub>3</sub> (Chintu) shown significantly higher number of tillers m<sup>-2</sup> over all other varieties followed by M<sub>2</sub> (Jagtial rice 1), which was on par with M<sub>1</sub> (Telangana sona). At 60 DAT, significantly higher number of tillers m<sup>-2</sup> were observed in M<sub>3</sub> (Chintu) over all other varieties followed by M<sub>1</sub> (Telangana sona), which was on par with M<sub>2</sub> (Jagtial rice 1). Similar trend like that of 60 DAT was observed at 90 DAT, at harvest.

The number of tillers m<sup>-2</sup> varied among the cultivars It might be due to differences in genetic makeup of these rice varieties. The results are in close conformity with Mali and Choudhary [13] and Sarwar et al.[17].

#### 3.1.2.2 Performance of rice under varied sowing and harvesting dates

At 30 DAT, S<sub>5</sub> (Delay sowing by 30 days (December 15) and harvesting at physiological maturity) shown significantly higher number of tillers m<sup>-2</sup> over all other treatments followed by S<sub>6</sub> (Delay sowing by 30 days (December 15) and harvesting at 7 days after physiological maturity), which was on par with S<sub>3</sub> (Delay sowing by 15 days (November 30) and harvesting at physiological maturity). The lowest values of number of tillers m<sup>-2</sup> were observed in S<sub>2</sub> (Normal sowing time (November 15) and harvesting at 7 days after physiological maturity). At 60 DAT, Significantly higher number of tillers m<sup>-2</sup> were observed in S<sub>5</sub> (Delay sowing by 30 days (December 15) and harvesting at physiological maturity) and was on par with S<sub>6</sub> (Delay sowing by 30 days (December 15) and harvesting at 7 days after physiological maturity), however S<sub>6</sub> (Delay sowing by 30 days (December 15) and harvesting at 7 days after physiological maturity) was inturn on par with S<sub>3</sub> (Delay sowing by 15 days (November 30) and harvesting at physiological maturity). The lowest number of tillers m<sup>-2</sup> was found in S<sub>2</sub> (Normal sowing time (November 15) and harvesting at 7 days after physiological maturity). At 90 DAT, similar trend was observed like that of 60 DAT. At harvest, S<sub>5</sub> (Delay sowing by 30 days (December 15) and harvesting at physiological maturity) shown significantly higher number of tillers m<sup>-2</sup> and was on par with S<sub>3</sub> (Delay sowing by 15 days (November 30) and harvesting at physiological maturity) and S<sub>6</sub> (Delay sowing by 30 days (December 15) and harvesting at 7 days after physiological maturity), however S<sub>6</sub> was on par with S<sub>4</sub> (Delay sowing by 15 days (November 30) and harvesting at 7 days after physiological maturity). The lowest values of tillers m<sup>-2</sup> were found in S<sub>2</sub> (Normal sowing time (November 15) and harvesting at 7 days after physiological maturity). This may be due to availability of

favorable soil and air temperature during growing cycle of the crop. Similarly these findings were supported by Sharma [19] and Osman et al. [15].

### 3.1.3 Dry matter accumulation

The data pertaining to dry matter accumulation was depicted in Table 3

#### 3.1.3.1 Rice Varietal performance

At 30 DAT, there was no significant difference in dry matter accumulation among varieties. At 60, 90 DAT and at harvest, significantly higher dry matter accumulation was observed in M<sub>1</sub> (Telangana sona) and was on par with M<sub>2</sub> (Jagtial rice 1). The lowest dry matter accumulation was observed in M<sub>3</sub> (Chintu). The difference in dry matter accumulation among the genotypes might be due to their genetic potential and differential plant height. Similar results were obtained by Dileep et al.[4].

#### 3.1.3.2 Performance of rice under varied sowing and harvesting dates

At 30, 60 and 90 DAT, significantly higher dry matter accumulation was found in S<sub>5</sub> (Delay sowing by 30 days (December 15) and harvesting at physiological maturity) and was on par with S<sub>6</sub> (Delay sowing by 30 days (December 15) and harvesting at 7 days after physiological maturity), which was in turn on par with S<sub>3</sub> (Delay sowing by 15 days (November 30) and harvesting at physiological maturity). The lowest values of dry matter accumulation was found in S<sub>2</sub> (Normal sowing time (November 15) and harvesting at 7 days after physiological maturity). At harvest, significantly higher dry matter accumulation was found in S<sub>5</sub> (Delay sowing by 30 days (December 15) and harvesting at physiological maturity) and was on par with S<sub>6</sub> followed by S<sub>3</sub> (Delay sowing by 15 days (November 30) and harvesting at physiological maturity), which was in turn on par with S<sub>4</sub> (Delay sowing by 15 days (November 30) and harvesting at 7 days after physiological maturity). The lowest values of dry matter accumulation were found in S<sub>2</sub> (Normal sowing time (November 15) and harvesting at 7 days after physiological maturity). Increase in plant height, tillers hill<sup>-1</sup> resulted in better interception of sunlight and efficient photosynthesis thus provided favourable condition for enhancement of dry matter production during sowing of rice in mid of December. These findings are in accordance with Duvvada et al.[5]

### 3.2 Grain yield

The data pertaining to grain yield was depicted in Table 3

#### 3.2.1 Rice Varietal performance

Among different varieties tested, M<sub>1</sub> (Telangana sona) shown significantly higher grain yield and was on par with M<sub>2</sub> (Jagtial rice 1). The lowest values of grain yield were found in M<sub>3</sub> (Chintu). The superiority of Telangana sona and Jagtial rice 1 might resulted from its better growth character *i.e.*, dry matter accumulation. These results are in accordance with Bindu [2]

#### 3.2.2 Performance of rice under varied sowing and harvesting dates

S<sub>5</sub> (Delay sowing by 30 days (December 15) and harvesting at physiological maturity) shown significantly higher grain yield over all other treatments followed by S<sub>6</sub> (Delay sowing by 30 days (December 15) and harvesting at 7 days after physiological maturity), which was on par with S<sub>1</sub> (Normal sowing time (November 15) and harvesting at physiological maturity) and S<sub>3</sub> (Delay sowing by 15 days (November 30) and harvesting at physiological maturity). The lower values of grain yield were found in S<sub>2</sub> (Normal sowing time (November 15) and harvesting at 7 days after physiological maturity). The increased yield might be due to result of higher dry

matter accumulation associated with favorable weather condition responsible for more growth and development resulted in more storage of photosynthates in the grain. These results are in accordance with Anil and Siddi [1] and Chendge et al. [3].

#### **Interaction of rice varieties, sowing and harvesting dates**

The interaction effect was found non significant for plant height, number of tillers  $m^{-2}$ , dry matter accumulation and grain yield of rice crop.

**Comment [A3]:** Please clearly specify which weather parameter is favoring the increase in yield and why?

**Table 1. Plant height (cm) at different growth intervals of rice as influenced by varieties, sowings and harvesting dates**

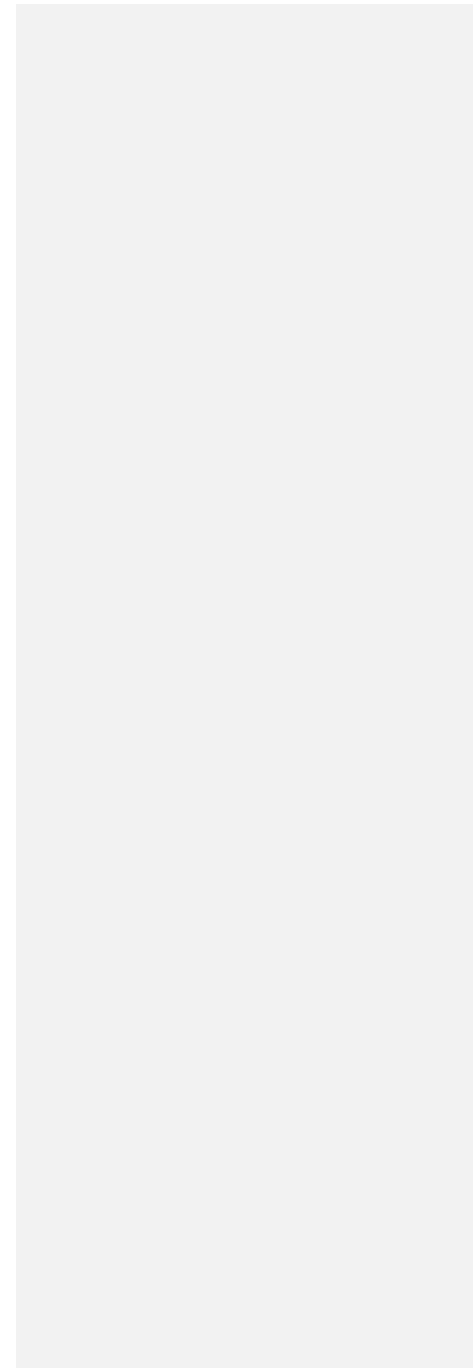
<b>Treatments</b>	<b>30 DAT</b>	<b>60 DAT</b>	<b>90 DAT</b>	<b>Harvest</b>
<b>Main plots : Varieties</b>				
<b>M<sub>1</sub></b> - Telangana sona	54.0	75.4	82.3	93.8
<b>M<sub>2</sub></b> - Jagtial rice 1	50.1	67.1	73.4	82.9
<b>M<sub>3</sub></b> - Chintu	47.8	65.7	71.6	80.1
SE(m)±	1.07	1.17	2.62	2.62
CD (p=0.05)	4.2	4.6	10.3	10.3
<b>Sub plots: Sowing and harvesting dates</b>				
<b>S<sub>1</sub></b> - Normal sowing time (November 15) and harvesting at physiological maturity	46.8	63.3	71.4	81.7
<b>S<sub>2</sub></b> - Normal sowing time (November 15) and harvesting at 7 days after physiological maturity	43.1	60.8	69.2	78.5
<b>S<sub>3</sub></b> - Delay sowing by 15 days (November 30) and harvesting at physiological maturity	51.4	70.7	75.7	86.0
<b>S<sub>4</sub></b> - Delay sowing by 15 days (November 30) and harvesting at 7 days after physiological maturity	51.2	67.5	72.0	81.4
<b>S<sub>5</sub></b> - Delay sowing by 30 days (December 15) and harvesting at physiological maturity	57.0	78.1	84.1	94.4
<b>S<sub>6</sub></b> - Delay sowing by 30 days (December 15) and harvesting at 7 days after physiological maturity	54.4	75.8	82.3	91.7
SE(m)±	1.13	1.04	1.76	1.76
CD (p=0.05)	3.6	3.3	5.5	5.5
<b>Interaction</b>				
<b>M×S</b>				
SE(m)±	1.59	2.22	3.48	3.48
CD (p=0.05)	NS	NS	NS	NS
<b>S×M</b>				
SE(m)±	1.58	2.06	2.78	2.78
CD (p=0.05)	NS	NS	NS	NS

**Table 2** Number of tillers m<sup>-2</sup> at different growth intervals of rice as influenced by varieties, sowing and harvesting dates

Treatments	30 DAT	60 DAT	90 DAT	Harvest
<b>Main plots : Varieties</b>				
M <sub>1</sub> - Telangana sona	297	397	383	359
M <sub>2</sub> - Jagtial rice 1	305	376	359	353
M <sub>3</sub> - Chintu	482	590	579	566
SE(m)±	7.07	12.58	12.65	15.50
CD (p=0.05)	28	49	50	61
<b>Sub plots: Sowing and harvesting dates</b>				
S <sub>1</sub> - Normal sowing time (November 15) and harvesting at physiological maturity	330	430	416	403
S <sub>2</sub> - Normal sowing time (November 15) and harvesting at 7 days after physiological maturity	312	404	398	389
S <sub>3</sub> - Delay sowing by 15 days (November 30) and harvesting at physiological maturity	369	457	446	436
S <sub>4</sub> - Delay sowing by 15 days (November 30) and harvesting at 7 days after physiological maturity	352	443	429	419
S <sub>5</sub> - Delay sowing by 30 days (December 15) and harvesting at physiological maturity	418	512	490	462
S <sub>6</sub> - Delay sowing by 30 days (December 15) and harvesting at 7 days after physiological maturity	389	479	463	446
SE(m)±	9.00	10.96	8.48	8.51
CD (p=0.05)	28	35	27	27
<b>Interaction</b>				
<b>M×S</b>				
SE(m)±	16.66	21.55	21.96	23.19
CD (p=0.05)	NS	NS	NS	NS
<b>S×M</b>				
SE(m)±	16.83	19.81	18.93	18.36
CD (p=0.05)	NS	NS	NS	NS

Treatments	30 DAT	60 DAT	90 DAT	Harvest	Grain yield (kg ha <sup>-1</sup> )
<b>Main plots : Varieties</b>					
M <sub>1</sub> - Telangana sona	4366	9120	13115	14263	6127
M <sub>2</sub> - Jagtial rice 1	4117	8880	12863	14005	6000
M <sub>3</sub> - Chintu	3679	7592	10858	11979	4927
SE(m)±	236.41	189.33	187.81	195.13	92.99
CD (p=0.05)	NS	743	737	766	365
<b>Sub plots: Dates of sowings and harvestings</b>					
S <sub>1</sub> - Normal sowing time (November 15) and harvesting at physiological maturity	3585	7916	11688	12832	5665
S <sub>2</sub> - Normal sowing time (November 15) and harvesting at 7 days after physiological maturity	3243	7573	11310	12475	5316
S <sub>3</sub> - Delay sowing by 15 days (November 30) and harvesting at physiological maturity	4168	8741	12436	13517	5663
S <sub>4</sub> - Delay sowing by 15 days (November 30) and harvesting at 7 days after physiological maturity	3907	8334	12104	13284	5395
S <sub>5</sub> - Delay sowing by 30 days (December 15) and harvesting at physiological maturity	4901	9564	13363	14501	6235
S <sub>6</sub> - Delay sowing by 30 days (December 15) and harvesting at 7 days after physiological maturity	4520	9055	12771	13885	5835
SE(m)±	129.64	204.82	190.71	188.94	74.52
CD (p=0.05)	409	645	601	595	235
<b>Interaction</b>					
<b>M×S</b>					
SE(m)±	359.38	410.38	400.61	401.03	223.48
CD (p=0.05)	NS	NS	NS	NS	NS
<b>S×M</b>					
SE(m)±	286.23	399.73	384.29	380.53	205.57
CD (p=0.05)	NS	NS	NS	NS	NS

**Table 3 Plant dry matter accumulation (kg ha<sup>-1</sup>) at different growth intervals and grain yield (kg ha<sup>-1</sup>) as influenced by varieties, sowing and harvesting dates**



**Figure 1 Plant height (cm) at different growth intervals of rice as influenced by varieties, sowing and harvesting dates**

**Figure 2 Number of tillers m<sup>-2</sup> at different growth intervals of rice as influenced by varieties, sowing and harvesting dates.**

**Figure 3 Dry matter accumulation (kg ha<sup>-1</sup>) at different growth intervals of rice as influenced by varieties, sowing and harvesting dates.**

**Figure 4 Grain yield (kg ha<sup>-1</sup>) of rice as influenced by varieties, sowing and harvesting dates.**

#### **4. CONCLUSION AND RECOMMENDATIONS**

Based on the research work, it can be inferred that among the varieties, Telangana sona (M<sub>1</sub>) performed better in terms of growth and grain yield. Among different sowing and harvesting times, Delay sowing by 30 days (December 15) and harvesting at physiological maturity (S<sub>5</sub>) will be more effective in obtaining better growth and higher grain yield under *rabi* conditions.

#### **ETHICAL APPROVAL**

No ethical issues were reported during the research work.

#### **REFERENCES**

1. Anil, D and Siddi, S. Performance of pre released rice (*Oryza sativa* L.) Genotypes under Different Sowing Windows in *rabi* Season. International Journal of Environment and Climate Change. 2020; 10(10): 43-51.
2. Bindu, G.S. Effect of cold on the performance of rice varieties sown on different dates during *rabi* .M.Sc.Thesis.2004. Acharya N.G Ranga Agricultural university , Hyderabad, India.
3. Chengde PD, Chavan SA, Ashwini patil, Shalu Kumar. Effect of sowing times on yield and economics of different rice genotypes under climatic condition of Konkan. Journal of Pharmacognosy and Phytochemistry. 2017;6(5):2462-2466.
4. Dileep K, Pasupalak S, Baliarsingh A. Effect of establishment methods and sowing time on growth and yield of rice varieties (*Oryza sativa* L.). The Pharma Innovation Journal. 2018;7(4):904-907.
5. Duvvada, S.K., Mishra, G.C., Maitra, S. and Adhikary. Effect of irrigation regimes and staggered transplanting on growth and yield of summer rice (*Oryza sativa* L.) in South

**Comment [A4]:** All references should be cited in the body of the manuscript and vice-versa. All references should be arranged strictly as per the journal format. Please Check.

- Odisha. International Journal of Agriculture, Environment and Biotechnology.2020;13 :205-211.
6. Food and Agriculture Organisation, 2019. <https://fao.org.in/>
  7. Food Corporation of India. Government of India.2019-20. <https://fci.org.in/>
  8. Farrell,T.C. Avoiding low temperature damage in Australia's rice industry with photoperiod sensitive cultivars. 2003.
  9. Government of Telangana, Department of Agriculture.2020-21.
  10. Government of India. Ministry of Agriculture and farmers welfare, Department of Agriculture, 2020-21. <https://www.indiastat.com/>
  11. Kapoor, A., Singh, I., Serawat, M., Dhaiya, S., Meena, D and Meena, B.R.Effects of different dates of transplanting on yield attributes, yields and quality of non-scented varieties of rice (*Oryza sativa* L.). International Journal of Chemical Studies.2017; 5(6):831-833.
  12. Koireng RJ, Devi NM, Devi KP, Gogoi M, Anal PSR. Effect of variety and spacing on the productivity of direct seeded rice (*Oryza sativa* L.) under Manipur condition. Indian Journal of Pure and Applied Biosciences. 2019;7(5):335-341.
  13. Mali H, Choudhary J. Performance of bread wheat (*Triticum aestivum* L.) varieties under different row spacing. Journal of Wheat. 2011;4(2):55-57.
  14. Nizamani GS, Imtiaz AK, Abdula K,Siddiqui MA, Nizamani MR, Khaskheli MI. Influence of different row spacing on agronomic traits in different wheat varieties. International Journal of Development Research. 2014;(411):2207-2211.
  15. Osman KA, Mustafa AM, Elsheikh YMA, Idris AE. Influence of different sowing dates on growth and yield of direct seeded rice (*Oryza sativa* L.) in semi-arid zone. International Journal of Agronomy and Agricultural Research. 2015;6:38-48.
  16. Patra, P.S and Haque, S.Effect of seedling age on tillering pattern and yield of rice (*Oryza sativa* L.) under system of rice intensification. Asian Research Publishing Network Journal of Agricultural and Biological Science. 2011;6(11):33-35.
  17. Sarwar, A.K.M. Golam, Sohel, S.A., Islam, M.A., Ashrafuzzaman, M. Palynological features and grain yield of rice as influenced by air temperature and relative humidity. Bangladesh Journal of Botany.2017; 46: 947- 954.
  18. Suleiman AA, Nganya JF, Ashraf MA.Effect of cultivar and sowing date on growth and yield of wheat (*Triticum aestivum* L.) in Khartoum, Sudan. Journal of Forest Products & Industries. 2014;3(4):198-203
  19. Sharma A, Dhaliwal LK, Sandhu SK, Singh S. Effect of plant spacing and transplanting time on phenology, tiller production and yield of rice (*Oryza sativa* L.). International Journal of Agricultural Science. 2011;7:249-253.

